Current Practice

FORENSIC MEDICINE AND TOXICOLOGY

Medical Investigation in Cases of Sudden Death

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A medical practitioner called to examine a person presumed to be dead must first make sure that death has in fact occurred. Failure to carry out this seemingly obvious preliminary examination has occasionally had serious results.

In most cases the doctor would be justified in stating that death has occurred if he has been unable to hear a breath or heart sound on auscultation over a period of five minutes. In noting loss of body warmth, particularly in elderly persons, care must be taken to exclude a state of hypothermia, which may be associated with barbiturate or alcohol poisoning. Stasis and fragmentation of the contents of the retinal blood vessels is a time-honoured and reliable additional sign of death.

Whenever the diagnosis of death is in doubt an electrocardiograph should be carried out.

Unusual Circumstances

After establishing that death has occurred, the doctor must look for any evidence that it may have been due to unnatural causes. He may be the first responsible observer on the scene, and he should note carefully anything unusual about the body or its surroundings. The body or nearby articles may have been moved, probably innocently but perhaps by interested parties anxious to dispose of containers, to remove incriminating objects, or to clear the room of, say, coal gas.

It is particularly important, especially in women, to notice any disarrangement of the clothing which might suggest a struggle or sexual interference. Haemorrhages from cuts along the prominences of the eyebrows or on the cheeks, nose, or occiput suggest that the dead person may have fallen as a result of violence. These must not be confused with post-mortem changes which allow haemorrhagic fluid from the lungs and congested nasal vessels to stain the face. This may occur naturally with decomposition, but is more prominent when death is from asphyxia. Pools of haemorrhage around the head will, of course, require detailed investigation, particularly if splashes and "exclamation marks" of blood are seen on adjacent walls and floors.

In any dead person, particularly women, the face and neck should be viewed in a good light for presence of abrasions, pressure marks, or concomitant evidence of mechanical asphyxia in the form of facial suffusion, cyanosis, and petechial haemorrhages, particularly in the conjunctivae, mucous membrane of the mouth, and the skin above the level of constriction. Their extent and severity depend on the degree of pressure that had been exerted on the skin and the speed and severity of obstruction to the air passages and blood vessels of the head.

Manual strangulation and strangulation by ligature are invariably homicidal, while hanging is most commonly suicidal. Accidental hangings are usually associated with some form of sexual deviation. However, a conclusion that a hanging is self-inflicted should not be arrived at before a post-mortem examination and a reconstruction of the event with the means of suspension employed, which should be kept for further study. The possibility that the deceased was suspended after death from another cause must be excluded.

In children there may be no external signs of violence, and this particularly applies in cases of traumatic intracranial haemorrhage with or without fracture of the skull. Such injuries are sometimes associated with intraperitoneal haemorrhage from laceration of the liver and mesenteries, which may occur in the absence of subcutaneous bruising. The battered baby syndrome is now well recognized.

Time of Death

Reliance should not be placed on a single post-mortem sign as evidence of the time of death. To do so will inevitably result in inaccuracy and dogmatism, both of which could lead to a serious medico-legal error. There are exceptions to the development of even well-defined post-mortem changes. In most cases only an approximate time of death can be given. Circumstantial evidence, such as may be gained from an examination of the stomach contents, can be valuable.

Early Post-mortem Changes

Three early post-mortem changes in particular are of assistance in estimating the time of death.

Firstly, the rate of cooling of the body should be ascertained. An ordinary clinical thermometer is of little value for this purpose. A special thermometer reading from 0 to 100° F. (−15 to 38° C.) and adapted for taking rectal temperatures must be used. The metal-encased "Rototherm" thermometer, made by Alfred Cox (Surgical) Limited, is designed for recording the temperature of internal organs. In the case of the liver a small incision is made through the abdominal wall, which generally requires little disturbance of the body or clothing, and a similar technique can be used in other sites.

The body temperature may be abnormally high at the time of death in such conditions as pontine haemorrhage, barbiturate and aspirin poisoning, and, of course, fever due to any cause. In hypothermia the body temperature may vary from 75 to 90° F. (24 to 32° C.). It used to be thought that the rate of post-mortem cooling was uniform, but it is now known that body temperature is maintained for a few hours after death and after that the fall in temperature is quite rapid. Then, as environmental temperature is reached, the process of cooling becomes slower. A convenient guide is that the temperature falls between 1 and

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2° F. (0.5 and 1° C.) per hour over the first ten hours. Alternatively the following equation may be used:

$$\frac{98.4^\circ \text{ F.} - \text{rectal temperature}}{1.5} = \text{hours dead.}$$

It is of the utmost value to take temperature readings at intervals for several hours after death.

Secondly, post-mortem lividity, due to hypostasis of blood that has gravitated after death, should be looked for in the dependent parts other than those exposed to pressure from clothing or resting on a flat surface. Lividity usually begins to show within one to two hours of death and becomes fixed within six to twelve hours. Thus it is useful not only as evidence of the time of death but also that death has occurred. It also provides evidence of the position of the body after death.

The third change to look for is rigor mortis. Its development is subject to a number of factors. It is accelerated by gross violence or exertion shortly before death. Rigor mortis is usually established within six hours in the muscles of the face and in those around the smaller joints such as the jaw, hands, and feet. It becomes fully developed throughout the body in 12 hours, persists for 12 hours, and passes off within the next 12 hours in the reverse order to that in which it developed. It depends on complex physicochemical changes in the muscle fibres.

The rare phenomenon of cadaveric spasm or instantaneous rigor, which causes grass or a weapon to remain clenched in the hands after a violent death, may sometimes be encountered. It remains after rigor mortis has passed off. Instantaneous rigor may help to confirm that a firearm wound was self-inflicted when it causes the weapon to remain firmly grasped in the hand.

Later Post-mortem Changes

As rigor mortis passes off the progress of putrefaction due to the multiplication of anaerobic micro-organisms and enzymatic changes accelerates. Putrefactive changes become apparent more quickly when antemortem sepsis existed. The characteristic "marbling" so often seen in bodies three to four days after death is caused by the growth of anaerobic micro-organisms along the blood vessels. In a case of death from septic abortion they can appear within 24 hours. Putrefaction also depends on environmental factors. Low temperatures, such as when the body is immersed in water, delay decomposition. A body exposed to dry heat in a draught can become mummified, or when moist environmental conditions exist it can develop adipocerous changes.

Decomposition of the body tissues will, especially in hot weather, attract flies, which lay eggs that develop into maggots. Similarly, changes in the vegetation beneath and around the body deserve attention, particularly if the deceased has been lying for some time in open ground. However, these matters are more the province of entomologists, botanists, and pathologists.

Examination of Wounds

Accurate observation of the nature of wounds is highly important not only in relation to their causation and severity but also to the interval of time since their occurrence.

Evidence of free haemorrhage usually means that the wound was received before death, though fractures of the legs occurring at the same time as other serious injuries may be associated with little or no haemorrhage into the adjacent tissues. However, oozing of blood from scalp wounds may continue after death, particularly if the body is moved. Similarly, blood from a chest wound may accumulate within the pleural cavity.

Capillary vessels damaged during life cause blood cells to infiltrate the interstitial tissues. This may also occur after death but not so extensively, and this helps to distinguish an antemortem from a postmortem bruise. The migration of leucocytes and monocytes may also be an aid in timing the occurrence of an injury. When a mild injury occurs without haemorrhage some swelling due to oedema develops, and histological examination of such areas may show the presence of fibrin and leucocytes. These changes can occur up to half an hour after death.

Any wound may have medico-legal significance, either in a civil or criminal court, and among the questions that arise are: How was it inflicted? What instrument caused it? What force was required to produce it? These must be considered in detail.

Abrasions.—These are caused by friction of the skin against a rough surface. They may be scratches, which are formed by the heaping up of the outer cuticle by a very narrow but sharp object such as a pin or finger-nail, or grazes, which are very similar to scratches but caused by contact with a broader, rougher surface. They are commonly seen after a fall, particularly on exposed angulated surfaces, and may incorrectly be dismissed as unimportant.

Pressure abrasions are caused by direct impact on to the skin surface rather than along it, as in the case of grazes. Examination with a hand lens will often distinguish the direction of impact of an abrasion, but the outline of the wound is of greater significance, because it may give a clue to the identity of the striking object.

Serum oozes from an abraded surface and then dries, and this may help to distinguish it from a post-mortem injury, which has a much drier, parchment-like appearance.

Bruises.—These are essentially blood from ruptured blood vessels that has collected in the subcutaneous tissues. Bruises present more problems in interpretation than other injuries since they may occur in either superficial or deep tissues, they may track along tissue planes after death, and their ante-mortem nature is more difficult to assess than in abrasions. The time of their occurrence can be given only approximately. In general terms superficial bruises about 24 hours old are dark red or black, those that are two to seven days old are a greenish colour, and those that are one to two weeks old are yellow.

Post-mortem bruises may resemble closely those inflicted during life, but perhaps the greatest difference is that a post-mortem bruise can rarely be extensive. It is very important to differentiate ante-mortem from post-mortem bruising in situations such as the neck or thighs. The extent of a bruise depends more on the laxity of tissues involved than on the force used—for example, a heavy blow, particularly in children, may cause severe internal injuries without visible bruising.

Lacerations.—These are a splitting of the skin surface caused by abrupt contact with a blunt object or by impact against a hard surface. They are commonly seen on the head, where they must be carefully distinguished from incised wounds. Their edges are characteristically abraded and the deeper tissues crushed without the blood vessels necessarily being severed, so that haemorrhage is often much less than from incised wounds. In tangential impacts the skin is torn irregularly away from the underlying tissues to form a loose flap at the edge of which a scraping-patterned abrasion may be seen.

Incised Wounds.—These are caused by any sharp object or instrument. They have clean-cut edges, they are longer than they are deep, and they are commonly associated with profuse haemorrhage from divided blood vessels. Whether self-inflicted or not, their presence indicates a degree of intent. A "cut throat" is almost always self-inflicted, with tentative incisions characteristically at one edge. "Protective" incised wounds are caused by the victim holding up a hand in self-protection or in an attempt to grab the weapon.

Stab Wounds.—These are recognized by their degree of penetration, their depth being much greater than their length. Often the external wound is small in proportion to the degree of internal damage inflicted. The shape of the external wound may indicate the type of weapon used, but it is difficult to distinguish a suicidal from a homicidal stab wound by appearances alone.

Electrocution

Electrocution should be considered in any unusual death in the home or factory. Electricity may cause burns at both entrance and exit from the body, but characteristically the mark is seen at the point of entry. It consists of a small, brownish-coloured, oval or linear depression surrounded by a pale weal and an outer margin of congested skin. Careful examination of the extremities is therefore essential for its observation, although occasionally no mark or burn can be seen on the skin. The effect of an electric current is enhanced by moisture on the skin or a damp environment plus good earthing. In the case of high-tension current extensive burns and charring of the tissues may occur.

Criminal Abortion

Criminal abortion should be in the doctor's mind in a case of sudden death in any woman of child-bearing age, particularly when death has occurred in another person's house. Prompt action may result in a successful prosecution of an abortionist. The position of the deceased and her clothing should be noted, together with the presence of any drugs or instruments which may have been used to cause abortion.

Firearm Wounds

These will be rarely encountered, but a doctor should be able to recognize them.

A weapon fired in contact with the body will cause scorching and soiling of the skin by the products of explosion. This will be less the farther away the firearm is from the skin, and when the distance reaches an arm's length only a little marking by unburnt powder is possible. The exit wound will be a mere split or hole, generally smaller than the entry wound when the weapon is fired at close range, and apt to be larger when the range is more distant. Shotgun discharges naturally produce a much larger entrance and exit wound.

Any weapon, cartridge case, or ammunition must be carefully preserved for the ballistics expert. The doctor should not try to reconstruct the incident, nor should he palpate the wound edges.

Drowning

Accidental drowning in a domestic bath or when swimming is often caused by loss of consciousness due to cardiovascular disease or epilepsy. When suicidal it may be associated with ingestion of a barbiturate drug. In the young and enfeebled foul play must be excluded. The size of the bath in relation to the victim's height, the level of water, and the position of the body should be ascertained, particularly when the body has been moved from its original position by relatives or police.

Poisoning

The possibility of poisoning must be considered when apparently healthy persons are found dead at home without signs of injury. Carbon monoxide poisoning may be diagnosed easily, because its inhalation in lethal quantities produces a characteristic cherry red coloration in the areas of hypostasis. A similar reddish hue is seen in cases of cyanide poisoning.

In barbiturate poisoning tell-tale powdery debris, often stained pink (Seconal or Soneryl) or blue (Tuinal or Amytal), may be seen around the lips or on the tongue.

Investigating a Violent Death

A doctor called to what proves to be an unnatural or violent death may be responsible for a vital part of the medico-legal investigation. His report should be based entirely on his own observation and not on speculation or circumstantial information, though he must expect a full history from any attendant police officer. The doctor may initially be present in his capacity as a police surgeon. A forensic pathologist will be called later if required, and any subsequent investigation should be left to him.

Procedure

The doctor at the scene of a violent death should see to it that nothing is disturbed before the arrival of police officers. Masterly inactivity is the keynote at this stage of the investigation.

Though there is no set pattern of procedure, certain basic principles should be followed. Only essential people should be present ; there should be no smoking ; and rubber or polyethylene gloves should be worn to prevent fingerprint or other contamination. If objects are moved, whether purposely to examine the body or accidentally, this should be recorded and no attempt at approximate replacement made. For this reason photographs should be taken at the earliest opportunity. A sketch plan should also be made of the position of the body in relation to the surroundings. It will be invaluable for the subsequent reference, and it may draw attention to significant articles which might otherwise have been missed.

As much external examination as is possible without unnecessary disturbance of the body should be made. It should include recording the body temperature and noting the presence of rigor mortis, any unusual coloration of the exposed parts, the distribution of blood stains on adjacent walls or furniture, pools of blood in relation to the body, and the position of any knife or weapon.

Laboratory experts will take away specimens, including contact traces. Contact traces are materials found at the scene of a crime which may associate the dead person with a weapon, with an assailant, or with the environment—particularly if the body has been moved after death. They usually consist of fragments of glass, grass, leaves, fibres, blood, or other debris adherent to the body or clothing. The hands and fingernails should receive particular attention, since they may have collected blood, hair, or even skin-scrapings during a struggle. The hands should be covered by protective bags. If possible, swabs from the body orifices should be taken.

Finally, the doctor should supervise placing of the body in a plastic sheet to ensure that no material adherent to the clothing or surfaces is disturbed and lost. A responsible person should remain with the body until a complete examination is carried out.

Medical Report

The doctor should give much thought to his report. The value of correct observation and interpretation of wounds at the scene of death may be greatly diminished by slipshod notetaking or the use of medical jargon. The knowledge gained at the scene must be recorded as soon as possible. Every wound, however superficial, must be mentioned as well as significant negative findings. The doctor must rely on his notes made at the time of examination or a subsequent typescript if he wishes to refresh

his memory in the witness-box. Any subsequent record may be challenged, and rightly so.

When a patient is treated in casualty or admitted to hospital after an assault the examining doctor must be aware of the need for legible, concise notes in the patient's file. The height and approximate weight should be noted as well as any unusual physical features. The wounds themselves may be conveniently divided into major and minor ones and arranged in anatomical order—that is, head, extremities, chest, abdomen, etc. Their size, shape, margins, and depth, and, if applicable, which wound was responsible for death should be noted.

The factual report is quite separate from an opinion, which will be based upon consideration of all the findings and reference to the relevant textbooks or articles, perhaps after consultation with an expert.

Presentation of Evidence

The doctor will be expected to present his findings and views impartially whether he is called as a medical witness on behalf of the defence or for the prosecution. There is no place in the witness-box for bias of any kind, nor for anything but firm, courteous replies, even to counsel's most provocative questions. Judge and jury will expect medical evidence to be presented simply and clearly, and it should be the doctor's object to ensure that it is.

TODAY'S DRUGS

With the help of expert contributors we publish below notes on a selection of drugs in current use.

Benzodiazepines

The benzodiazepines constitute a relatively new chemical class of compounds which show unique taming effects in animals and anti-anxiety effects in humans. The first of these compounds to be marketed was chlordiazepoxide (Librium), since when diazepam (Valium), nitrazepam (Mogadon), and oxazepam (Serenid-D) have been introduced.

General Pharmacology

The action of benzodiazepines in animals is remarkable. Naturally or artificially induced aggressiveness is changed to docility, so that the animal may be petted yet is still alert and shows no impairment of movement. In laboratory animals the drugs show definite muscle relaxant properties and also anticonvulsant activity. This latter is useful as a pharmacological screening test, but though chlordiazepoxide may correct an abnormal E.E.G. it has not been shown to have anticonvulsant properties in clinical practice.

In the assessment of drugs of this kind special conditioning procedures are doubly interesting, and have been well reviewed by Heise.[1] Firstly, they delineate meprobamate and the benzodiazepines as a group of "anti-anxiety" compounds distinct from the phenothiazines and barbiturates (except phenobarbitone). Secondly, these "anti-anxiety" compounds distinctively improve the abnormal behaviour which is induced by a training programme of reward and punishment calculated to cause emotional "conflict" in certain situations (approach-avoidance). Scheckel and McConnell[2] have suggested that this improvement could be due to the drug attenuating the animals "learned" response to certain situations. Heise[1] goes on to speculate that anxious patients have "learned" many inappropriate "passive avoidance" responses in their attempts to cope with real and imaginary danger and conflicts, and under these circumstances drugs which attenuate such responses might well be beneficial.

The mode of action of the benzodiazepines is not known, but electrophysiological studies suggest that they (and meprobamate) probably act by depressing the limbic system. They have only slight depressant effects on the neocortex or reticular system, yet greatly increased electrical stimuli must be given to the amygdala or the reticular system to produce an evoked potential in the hippocampus. The calming of animals made vicious by "septal" lesions is consistent with a depressant action on the limbic system, as is the attenuation of "passive avoidance."

Clinical Use

Chlordiazepoxide, diazepam, and oxazepam are widely used in the treatment of symptoms of anxiety and tension. An ideal drug would relieve these symptoms without causing drowsiness or other side-effects and without the danger of addiction. Failing this ideal, the benzodiazepines must stand comparison with drugs already in use. Of these the barbiturates are certainly effective in relieving anxiety but tend to cause drowsiness, and there is some danger of addiction, especially if the drugs are given regularly. Particularly in the elderly their depressant properties on the neocortex may give rise to mental confusion. The phenothiazines are less effective in controlling anxiety and tension and may produce extrapyramidal side-effects even in small dosage. Meprobamate is the other drug in wide use in this type of patient. Controlled trials suggest that its anti-anxiety effects are slight,[3 4] and some cases of addiction have been reported.[5 6]

Chlordiazepoxide

This drug is chemically described as 7-chloro-2-methylamino-5-phenyl-3H-benzo-1,4-diazepine-4-oxide hydrochloride. It was the first of the benzodiazepines to be introduced. Controlled trials against placebo show that it has undoubted properties in relieving anxiety and tension,[7] and that chlordiazepoxide, 20 mg. t.d.s., is superior to amylobarbitone, 60 mg. t.d.s.[8] The usual recommended dose is 10 mg. repeated three or four times a day, though the daily dosage may be increased to at least twice that amount. Side-effects are few and virtually limited to drowsiness and ataxia, the latter being seen rarely except with high dosage. Other side-effects such as skin rashes have been reported on occasion. A recent report in the *B.M.J.* (18 March, p. 699) draws attention to the effect of chlordiazepoxide on thyroid-function tests. In general it is a very safe drug, and Hines[9] reported two patients who had taken 1,150 mg. and 1,600 mg. in 20 minutes and 24 hours respectively, neither patient requiring treatment.

Diazepam

This drug is chemically described as 7-chloro-2,3-dihydro-1-methyl-5-phenyl-1,4-benzodiazepin-2-one. Controlled trials against amylobarbitone have established its effectiveness in relieving anxiety and tension,[10 11] and on a weight for weight basis it is undoubtedly more potent than chlordiazepoxide.[12] This increased potency is offset to some extent by a greater tendency for diazepam to cause drowsiness and ataxia when the two drugs are given in equal dosage. However, in a multidose double-blind cross-over comparison, Jenner and Kerry[13]